

# ***EDUCATOR SUPPORT MATERIALS***

## ***Curriculum Structure***

### **Why are learning about energy issues important for today's youth?**

Energy issues have become one of the most important issues of today's world. How we heat homes, cook food, transport goods (and people), and create electricity impact our local community and have far-reaching effects around the world. Developing a basic understanding of the different forms of energy—and energy conversion processes—creates a cornerstone to understanding how the world works. Energy issues touch upon all aspects of life and education including understanding social systems, political policies, economic policies, environmental impacts, and technological research. In this curriculum, our hope, through emphasizing the interconnectedness and interdependence of the modern world, is that students will develop an understanding of how everyday decisions affect more than their selves.

### **Curriculum Goals**

The E.E.K! Project's focus is multi-fold. It aims to have students beginning in Kindergarten:

- develop and foster an interest in science;
- gain a working familiarity with energy-related concepts including: different forms of energy, energy conversion, energy measurement, energy efficiency, and power;
- explore the benefits, costs, and impacts of energy use;
- engage in real-world problem solving;
- explore the different roles energy plays in achieving a high quality of life; and
- develop an appreciation for how energy is used throughout the world and how it might be used in the future.

### **Curriculum Lesson-Modules**

This curriculum is intended to provide 10 lesson-modules for K-6 on energy education. Each lesson-module provides detailed information for educators to lead thoughtful, informed discussions and hands'-on exercises about energy, and energy uses. Within the ten lesson-modules for each grade, the first five lessons are devoted to more nuts-and bolts learning about energy: energy conversion and potential energy. The second five lessons build on this new learning and explore a world energy issue in detail. Each grades' lessons contiguously builds on the previous grades lessons with expanded overlap to provide more sophisticated discussions and experiments as the grades progress.

### **Lesson Preparation and Time Allotments**

While the curriculum is inherently flexible as to how much time is spent on each lesson-module, the curriculum should be taught in consecutive order given that each lesson directly builds on the previous one. The lesson-modules are large. Some larger than others, and we openly acknowledge that some of the lessons could take 3 –5 days each to adequately cover all the material. Therefore, we suggest in-service training to discuss timeline stipulations and questions concerning how the EEK! might enhance lessons you are already teaching within your curricular framework. The EEK! may also be used as a stand-alone curriculum module if so desired.

## **Basic Curriculum Structure**

At the beginning of each grade, you will find a curriculum outline and standards-correlation for each lesson-module. At the beginning of each lesson-module, you will find a lesson overview, a lesson concept, and background material. Also, if additional background materials (charts, statistics, etc.) are necessary, these will be found at the end of each lesson-module.

## **Assessment**

The modules have been created from an inquiry-based point of view and are intended to be taught in the Socratic teaching method. Nearly all lessons require either hands'-on experimentation or in-depth, open ended, "what-if" types of conversations between students facilitated by the teacher. Therefore, it is an antithetical approach to require pre- and post-tests of the students. We encourage educators to qualitatively evaluate the students knowledge based on the increase in knowledge and awareness from the first conversations during Lesson 1 to the final projects completed in Lesson 10 of each grade.

At the end of each grade's module, there are Feedback Forms. These are questions for the teachers to answer based strictly on the work created by the students. They also account and respect the need to provide letter grades and provide an assessment framework for each grade.

## **Support Materials**

A variety of trade books and a few videos have been chosen as support to the curriculum. The majority of these materials can be purchased from Scholastic or are in-print and easily found on Amazon or at specific websites provided.

## **Kit Components / Tools**

The tools used for the student experiments range from common, everyday items (jump ropes, whistles) to tools used in the field of energy conservation (IR thermometers, watt meters, etc). A detailed list of where to find these tools is provided. This list has been well researched for quality products that will hold up to elementary aged children using them as well as being competitively priced. For the most part, the tools are not expendable items and will hopefully be used year after year.

## **Building the Solar Ovens (4th grade)**

The 4<sup>th</sup> grade curriculum culminates in building and testing solar ovens. (The 2<sup>nd</sup> and 3<sup>rd</sup> grade curriculum has minor testing of the ovens but does not call for building them.) Kalamazoo Valley Museum in downtown Kalamazoo has offered to provide solar oven building workshops for all educators / schools using the EEK! curriculum. Detailed information concerning cost and contacting KVM are included in the Resource section of the curriculum.

# *EDUCATOR SUPPORT MATERIALS*

## *WHAT IS ENERGY?*

*All living beings depend on energy conversion for their survival.*

### **Defining Energy**

Energy can be precisely measured and accurately predicted how it will change from one form to another, but when experts in the field of energy define what the word “energy” means, the discussion often revolves around how it behaves and what it provides. Therefore, when we use the term energy we are discussing what is being used (or what is happening) to ‘get things done’ or accomplish work.

There are many forms of energy and energy is around us all the time. Some forms of energy are used to cool or heat our homes, power lights, cook our food, power trains, busses, and cars, or allow us to run, jump, think, and play. Energy causes movement. Anytime you see a leaf blowing in the wind, a cloud moving across the sky, a car moving down the street, a spider spinning a web, a child reading a book you are witnessing energy being converted from one form into another and action taking place.

### **Energy Conversion**

When we discuss ‘energy’ most often what we are really talking about is the conversion of one type of energy into another. **Energy must be converted to get anything done or another way of saying this is: Energy must be converted to make things happen in the world.** Often, energy conversion is equated with accomplishing work. When energy is converted from one form to another it is always conserved. In many books you may have seen the equation of Energy Conversion = Work. We choose to introduce the subject to students, not as ‘work’ per say, but creating a result, an outcome. In other words, to do ‘play’—or ‘work’, depending on your point of view, all energy must be converted from one form of energy to another form of energy.

But, the most important idea to stress to the students is that a change occurs. Energy must be transformed and energy does not remain in a constant state. This key point is the guiding factor throughout the first week of lessons. Another issue that needs to be understood is that there is always a **potential to create energy** and a **result of creating energy**. For example, burning logs to create heat. Logs have potential energy, but once they are ignited, an energy conversion takes place and thermal energy is released. When the logs are ignited, chemical bonds are broken and new ones are created. In the process, thermal energy is released.

## Conservation of Energy: One of the most fundamental universal principles

In a closed system, no net energy is ever lost. In any energy conversion process all of the energy can be accounted for. Every form of energy can be turned into heat (thermal energy). Heat is created, whether wanted or not, in every mechanical energy conversion process.

Another way of thinking about this idea is: almost every form of energy can be changed into other forms of energy. But, whenever this happens in a closed system, the total amount of energy remains the same. There is the same amount of energy there was before even though it has changed into a different form. The important part of this concept to remember is that no energy has been either created or destroyed—it has changed form. This concept is referred to as ‘conservation of energy’, and is the first law of thermodynamics (there are two all together).

### 1<sup>st</sup> law and 2<sup>nd</sup> law of thermodynamics:

- **1<sup>st</sup> law—Conservation of energy:** In a closed system, no net energy is ever lost.
- **2<sup>nd</sup> law of thermodynamics:** The potential for useful work steadily diminishes as conversion of energy (in a chain effect) progresses.

## Different Forms of Energy

Below are a few examples of different forms of energy:

Form of Energy	Example of form of energy
Nuclear energy	Active stars and the sun are powered by nuclear energy
Thermonuclear energy	Reaches the Earth in the form of electromagnetic (radiant / solar) energy
Electromagnetic energy Radiant energy Solar energy	1/3 of the electromagnetic energy is reflected by clouds and surfaces. Nearly all the remaining electromagnetic energy is absorbed by oceans, land, and the atmosphere and then converted to thermal energy and reradiated by the planet.
Thermal energy	Heat
Chemical energy	A small part of the electromagnetic energy from the sun is transformed by photosynthesis into new energy stores in plants through photosynthesis.
Mechanical energy	The movement of any mass through space or air. Sound is a form of mechanical energy.

## Energy Conversion Matrix Chart

In the classroom, we are going to use a refined version of a basic energy conversion chart:

<b>From To</b>	<b>Electromagnetic (Solar)</b>	<b>Chemical</b>	<b>Thermal</b>	<b>Mechanical</b>	<b>Electrical</b>
<b>Electromagnetic (Solar)</b>		Chemiluminescence	Thermal radiation		Light bulb
<b>Chemical</b>	Photosynthesis	Chemical processing	Boiling		
<b>Thermal</b>	Solar hot water Solar hot air	Combustion Electromagnetic (light)	Heat exchanger	Friction Heat pump	Resistive heater
<b>Mechanical</b>		Internal combustion engine	Steam turbine	Gears	Electric motors
<b>Electrical</b>	Solar cells Solar calculator	Fuel cells Batteries	Thermocouple	Thermo-electricity Dynamo flashlight Wind turbine Electrical generator	Electrical circuit

Depending on the grade, you may be using an even more refined version (simplified) of this chart to reflect what will be taught in that particular grade.

## ASSESSMENT TOOLS

## EEK! Daily Assessment

[illegible]

### **Pre- and Post-Module Questions\***

1. Do you believe your actions affect others in the world?
2. Do you believe you have the ability to change the world?
3. Do you feel hopeful about the future of the world?

Question #1	Pre-Module Response	Post-Module Response
Do you believe your actions affect others in the world?		

Question #2	Pre-Module Response	Post-Module Response
Do you believe you have the ability to change the world?		

Question #3	Pre-Module Response	Post-Module Response
Do you feel hopeful about the future of the world?		

**\*These questions pertain to how their everyday decisions affect the global community re: energy issues and their affects on others' quality of life.**

## Assessment Question Sets

### General Assessment Questions

The following questions can be used to assess the individual lessons within each grade module. On the first page of each lesson, there is an assessment section that indicates a variety of assessment strategies for the lesson.

1. Is there an increase in thoughtful discussion?
2. Is there an increase in conflicting discussion?
3. Are students able to express their viewpoints fluently?
4. Are students actively engaged in the discussion / activity / project?
5. Are students speaking honestly about their viewpoints with each other?
6. Are students thinking creatively?
7. Are students extrapolating the lesson information and leading discussions to other, related topics of interest or importance in their lives?
8. Are students making connections between the impact of their personal decisions and the rest of the world?
9. Do students see a “big picture” of how the information they are studying relates to larger system of information?
10. Are students working together respectfully?

### Assessment Analysis Categories

The lessons are created to improve the students’ quality of thinking, analyzing, and processing of information across all subject areas. Below are highlighted learning strategies that serve as end-goal assessment analysis.

#### VALUES (HABITS OF MIND)

- Skepticism
- Curiosity
- Openness
- New ideas
- Questioning of facts
- Consequences of actions
- Looking for connections between actions and impacts
- Understanding cause and effect

#### PROCESSING SKILLS

- Observe
- Classify
- Infer outcomes
- Hypothesize
- Analyze
- Collect data

#### ASSESSMENT END-GOALS

- Flow and exchange of ideas
- Environmental understanding
- Affect of actions (life cycle analysis)
- Varied perspectives
- Living within a global community

## General Assessment Strategy #1

QUESTION	YES	IMPROVING	NO
1. Is there an increase in thoughtful discussion?			
2. Is there an increase in conflicting discussion?			
3. Are students able to express their views fluently?			
4. Are students actively engaged in the discussion / activity / project?			
5. Are students speaking honestly about their viewpoints with each other?			
6. Are students thinking creatively?			
7. Are students extrapolating the lesson information and leading discussions to other, related topics of interest or importance in their lives?			
8. Are students making connections between the impact of their personal decisions and the rest of the world?			
9. Do students see a “big picture” of how the information are studying relates to larger system of information?			
10. Are students working together respectfully?			

## General Assessment Strategy #2

VALUES (HABITS OF MIND)	YES	IMPROVING	NO
1. Is there an increase in <i>skepticism</i> ?			
2. Is there an increase in <i>curiosity</i> ?			
3. Is there an increase in <i>openness</i> ?			
4. Is there an increase in <i>new ideas</i> ?			
5. Is there an increase in <i>questioning of facts</i> ?			
6. Is there an increase in <i>understanding the consequences of actions</i> ?			
7. Is there an increase in <i>looking for connections between actions and impacts</i> ?			
8. Is there an increase in <i>understanding cause and effect</i> ?			

## General Assessment Strategy #3

PROCESSING SKILLS	YES	IMPROVING	NO
1. Is there an increase in the ability to <i>observe</i> ?			
2. Is there an increase in the ability to <i>classify</i> information?			
3. Is there an increase in the ability to <i>infer outcomes</i> ?			
4. Is there an increase in the ability to <i>hypothesize</i> ?			
5. Is there an increase in the ability to <i>analyze</i> information?			
6. Is there an increase in the ability to <i>collect data</i> ?			

## General Assessment Strategy #4

ASSESSMENT END-GOALS	YES	IMPROVING	NO
1. Is there an increase in the <i>flow and exchange of ideas</i> within the class?			
2. Is there an increase in the students' understanding of <i>environmental issues</i> ?			
3. Is there an increase in the students' understanding of <i>of the affects of their personal actions and decision-making throughout the world community</i> ?			
4. Is there an increase in the students' ability to accept <i>different perspectives other than their own on various topics of discussion</i> ?			
5. Is there an increase in the students' ability to understand that they <i>are living with a global community</i> ?			

# SUSTAINABLE FUTURES GROUP

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**HAROLD GLASSER, EXECUTIVE DIRECTOR**

**D JONES, EDUCATION DIRECTOR**

1918 Grand Avenue

Kalamazoo, MI 49006

269-383-0620

[sustainablefutures@hotmail.com](mailto:sustainablefutures@hotmail.com)

***Our future and the planet's rest on learning to question all our everyday actions and their impacts—openly and in public.***

## **Sustainability and Energy Education**

Formed in 1990, our mission is to facilitate social learning for sustainability. Through the building of a culture of sustainability via broad-scale outreach by collaborating with educators, schools, students, and businesses, we view this transition toward sustainability as necessitating the building of a more equitable and ecoculturally diverse world for all beings—present and future.

## **Guiding Principles**

The guiding principle of the Sustainable Futures Group is to employ a bottom-up, collaborative strategy based upon systems thinking and organizational learning principles. This requires active engagement with all stakeholders and a willingness to think out-of-the-box for both our clients and ourselves. Our goal is to leave our clients with the tools, resources, and collaborative decision-making and learning skills to complete the process of successfully implementing their collective vision on their own.

We find top-down, “expert-based” consulting to be antithetical to our mission. We see all of our consulting as a collaborative process. We see ourselves as helping to guide this collaborative process by helping organizations clarify their shared vision and providing new and innovative tools, techniques, strategies, and insights that help empower our clients to successfully implement this shared vision.

We demand of ourselves the same level of transparency, open dialogue, and critical reflection that we hope to illicit from our clients. Furthermore, we employ a dynamic, adaptive approach to problem-solving and critical analysis that we hope will be modeled throughout our clients’ work and personal lives.

## **Educational Model**

Our educational work focuses and includes the following topics of concern: alternative energy, renewable resources, environmental impacts, agricultural practices, food and nutrition, resource use, and arts integration within educational models and curriculum. Our current emphasis is on creating "cradle to cradle" models for teacher education based on systems-thinking approaches to teaching and learning.

This model has six key elements: integrating reason and emotion into teaching and learning; presenting and discussing unsustainable life choices and facilitating open forums within the classroom to discuss values; illuminating the conflicts and trade-offs between visions of a sustainable and desirable future and our everyday choices and the real (and potential) outcomes of these everyday actions; presenting a broad array of resources to support teachers in taking action (especially through developing community indicators); and creating a broad based, community-wide learning loop that will continually engage all parties in both the practical issues in education for sustainability and the meta issues, such as learning "how to decide how to decide".

Our hope is to build a culture of sustainability, one step at a time, by creating both an intergenerational network and a community-learning model that will spread widely.

## **Educational Expertise**

In order to help integrate sustainability across an institution's policy, operations, and mission we specialize in leading the following seminars and projects:

- Leading social learning and systems thinking seminars;
- Conducting sustainability assessment;
- Directing greenhouse gas emissions inventories;
- Teaching energy auditing (and teaching institutions how to self-audit;)
- Analyzing existing K-12 and higher education curriculum for sustainability topics;
- Incorporating standards alignment for K-12 curriculum (to reflect sustainability issues);
- Integrating sustainability topics / issues into existing curriculum;
- Developing new interdisciplinary sustainability curriculum;
- Leading EEK! for Sustainable Development in-service trainings.

## **The EEK! Project for Sustainable Decision-making**

The Energy Education Kit (EEK!) Project for Sustainable Decision-making is an innovative, hands-on, science-based, interdisciplinary curriculum that pairs portable, learning laboratory energy education kits with standards-aligned curriculum and exercises. The kits include tools and equipment to perform a variety of student-directed experiments in the classroom and curriculum that is easily assimilated into the already full calendar of the K - 6 teacher. This project provides K- 12 teachers with a self-contained science module on energy education that can be taught "as is" or used as a platform for creating expanded social science- and history-based energy education curriculum.

The EEK! Project's focus is multi-fold. It aims to have students beginning in Kindergarten:

- develop and foster an interest in science;
- gain a working familiarity with energy-related concepts including: different forms of energy, energy conversion, energy measurement, energy efficiency, and power;
- explore the benefits, costs, and impacts of energy use;
- engage in real-world problem solving;
- explore the different roles energy plays in achieving a high quality of life; and
- develop an appreciation for how energy is used throughout the world and how it might be used in the future.

The EEK! Project is framed as a 10-day curricular module. The curriculum builds on itself successively from K onward. Two teaching timelines are suggested: a two-week module or a 10-week module.

### **Curriculum Overview**

The K-6<sup>th</sup> grade curriculum focuses on the following topics:

- Social awareness of world energy use;
- Resource use and transportation of resources;
- Energy conversion;
- Renewable and non-renewable forms of energy; and
- Building analysis and energy use.

The 7<sup>th</sup>/8<sup>th</sup> grade curriculum focuses on transportation issues including:

- Transportation history;
- World fuel production;
- Automobile design;
- Automobile life cycle analysis;
- Consumer choice and decision-making; and,
- Potential future energy scenarios.

The high school curriculum (9<sup>th</sup> – 12<sup>th</sup>) focuses on building life-cycle analysis, building weatherization, and building auditing and includes:

- Energy use life-cycle analysis;
- Building design;
- Energy efficient design principles;
- Building weatherization issues;
- Lighting issues;
- How to conduct full-scale building audits; and,
- How to effectively implement changes to create more energy efficient buildings.

## Partners

**Harold Glasser** is an associate professor, (Ph.D., University of California, Davis) in the Environmental Studies Program and the Environmental Institute at Western Michigan University. His research focuses on the evaluation of complex environmental problems and the process of making individual and social choices about using and protecting the environment. He is a Senior Fellow at the University Leaders for a Sustainable Future (D.C), Chair of the EPA Colleges and Universities Sector Assessment Working Group, Director of the Campus Sustainability Assessment Project ([www.csap.envs.wmich.edu](http://www.csap.envs.wmich.edu)), Chair of Western Michigan University's Sustainability Committee, founding member of the WMU Campus Sustainable Design Committee, a member of the Economicology Group, and works with the Foundation for Deep Ecology as general editor of the 10 Volume *Selected Works of Arne Naess* (Kluwer Academic Press, 2005).

**D Jones** focuses on K-12 and teacher education. Ms. Jones was a master teacher in the California Public School System. She draws on more than 13 years of creative curriculum development and classroom teaching. Much of her work has focused on creating student directed curriculum that satisfies State Standards and benchmarks. She has worked on three Education Grants for the State of Michigan in the past four years. Prior to moving to Michigan, she served on California State Standards committee developing more learning-reflective Standards and Teaching Rubrics for English, Math, and Science.

*For information concerning the EEK! curriculum, teacher training workshops, and systems thinking approaches to teaching and learning seminars, please contact us at:*

*By e-mail:* [sustainablefutures@hotmail.com](mailto:sustainablefutures@hotmail.com)

*By phone:* [D Jones at SFG: 269-806-4067](tel:269-806-4067)